Fermi National Accelerator Laboratory

FERMILAB-Pub-79/66-THY
August 1979

Radiative Decay of Mesons in Broken SU(3)

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(Received

ABSTRACT

In this note we show how it is possible to fit the relative radiative decay rates of vector mesons using the vector dominance model with only one SU(3) breaking parameter.

PACS numbers: 11.30Jw, 12.40Vv, 13.40Hq.

Recently a number of papers[1] have been published on the subject of the radiative decays of vector mesons and the deviation of these relative decay rates from SU(3) symmetric predictions. Some of these papers have used several SU(3) breaking parameters in order to fit the data. In this note we shall indicate how it is possible to fit the data using the vector meson dominance model of Gell-Mann Sharp and Wagner[2] with only one SU(3) breaking parameter.

SU(3) symmetry breaking is introduced in two ways.

1. Photon-Vector Meson Junction.

The relative strength of the V-γ junctions has been investigated before by one of us[3] under the assumption of asymptotic nonet symmetry. It was found that

$$\frac{m_\rho^2}{f_\rho^2} : \frac{m_\omega^2}{f_\omega^2} : \frac{m_\phi^2}{f_\phi^2} = 3 : \sin^2\theta_V : \cos^2\theta_V \qquad (1)$$

where θ_V is the ω-ϕ mixing angle. According to the quadratic mass formula $\theta_V = 39^o$.

We may reinterpret Eq. (1) in terms of the quark model as

$$\frac{m_u}{m_s} \simeq \frac{m_\omega}{m_\phi} = 0.77 \ , \qquad (2)$$

in agreement with independent estimates (Barnes, Isgur[1]).

2. Vector Meson-Vector Meson-Pseudoscalar Meson Vertex.

The relative strengths of the V-V-P vertices has been studied before under the assumption of asymptotic nonet symmetry.[4]

It was found that the relative strengths of the coupling constants $g_{V_1V_2P}$ were given by

$$\frac{g_{V_1V_2P}}{m^2} = \frac{f_{V_1V_2P}}{m_{V_1}m_{V_2}} \quad , \tag{3}$$

where $f_{V_1V_2P}$ is the SU(3) symmetric coupling constant and m_{V_1}, m_{V_2} are the masses of the two vector mesons associated with that vertex.

Using the above prescription for SU(3) symmetry breaking, we plot some of the decay widths as a function of θ_P in Fig. 1. It can be seen that they are all consistent with θ_P=0 or θ_P equal to a small mixing angle. Therefore in Table I we list the various radiative decay widths calculated for a pseudoscalar mixing angle of zero and compare the results with experiment. The agreement is quite good except for $\rho\to\pi\gamma$. In particular we are able to give a satisfactory account of the recently measured width $\Gamma(\eta'\to\gamma\gamma)$.

FOOTNOTES AND REFERENCES

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FIGURE CAPTION

Fig. 1 Plot of decay rates as a function of the pseudoscalar mixing angle for various vector mesons. The horizontal lines represent the corresponding current experimental decay rates shown with bosons.

TABLE 1

Decay	Theoretical Width (KeV)	Experimental Width (KeV)
$\omega \to \pi\gamma$	(880)	880 ± 80 keV (5)
$\rho \to \pi\gamma$	103	35 ± 10 (6)
$\phi \to \pi\gamma$	5.7	5.7 ± 2 (5)
$\omega \to \eta\gamma$	3.8	3.0 ± 2.5 (7)
$\rho \to \eta\gamma$	40	50 ± 13 (7)
$\phi \to \eta\gamma$	52	55 ± 12 (7)
$\eta' \to \omega\gamma$	17	9 ± 4 (8),(9)
$\eta' \to \pi\pi\gamma$	118	89 ± 27 (8)
$\frac{\eta' \to \rho\gamma}{\eta' \to \omega\gamma}$	8.8	9.9 ± 2 (9)
$\phi \to \eta'\gamma$	0.09	—
$K^{*o} \to K^{o}\gamma$	102	<80 (10)
$K^{*+} \to K^{+}\gamma$	81	74 ± 35 (5)
$\pi \to \gamma\gamma$	(7.95(eV))	7.95 ± 0.55(eV) (5)
$\eta \to \gamma\gamma$	0.36	0.32 ± 0.05 (5)
$\eta' \to \gamma\gamma$	5.9	5.9 ± 1.6 (8)
$\eta \to \pi\pi\gamma$	0.057	0.042 ± 0.006 (5)

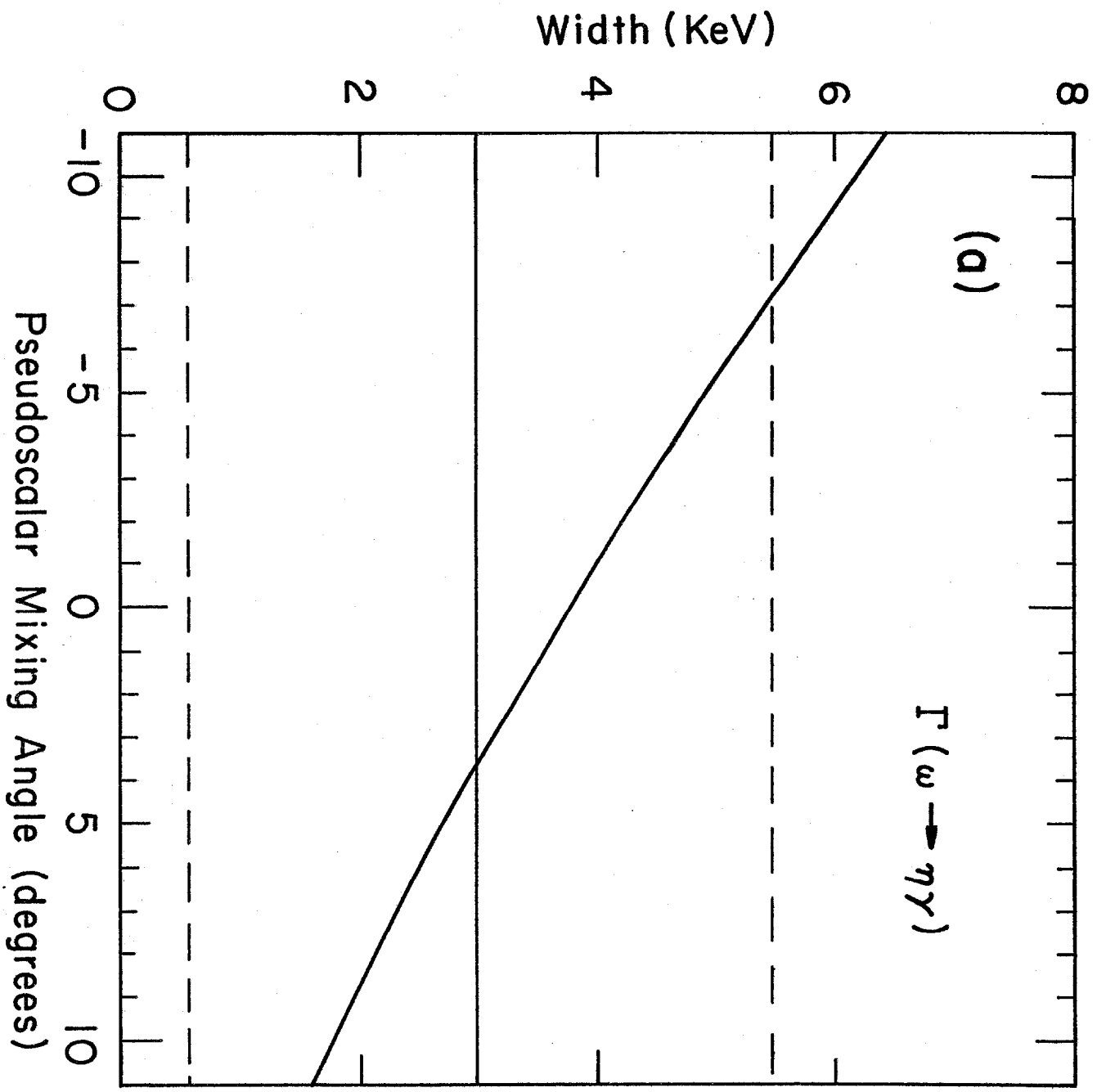

Width (KeV)
0
2
4
6
8
-10
-5
0
5
10
Pseudoscalar Mixing Angle (degrees)
(a)
Γ(ω → πγ)

Fig. 1(a)

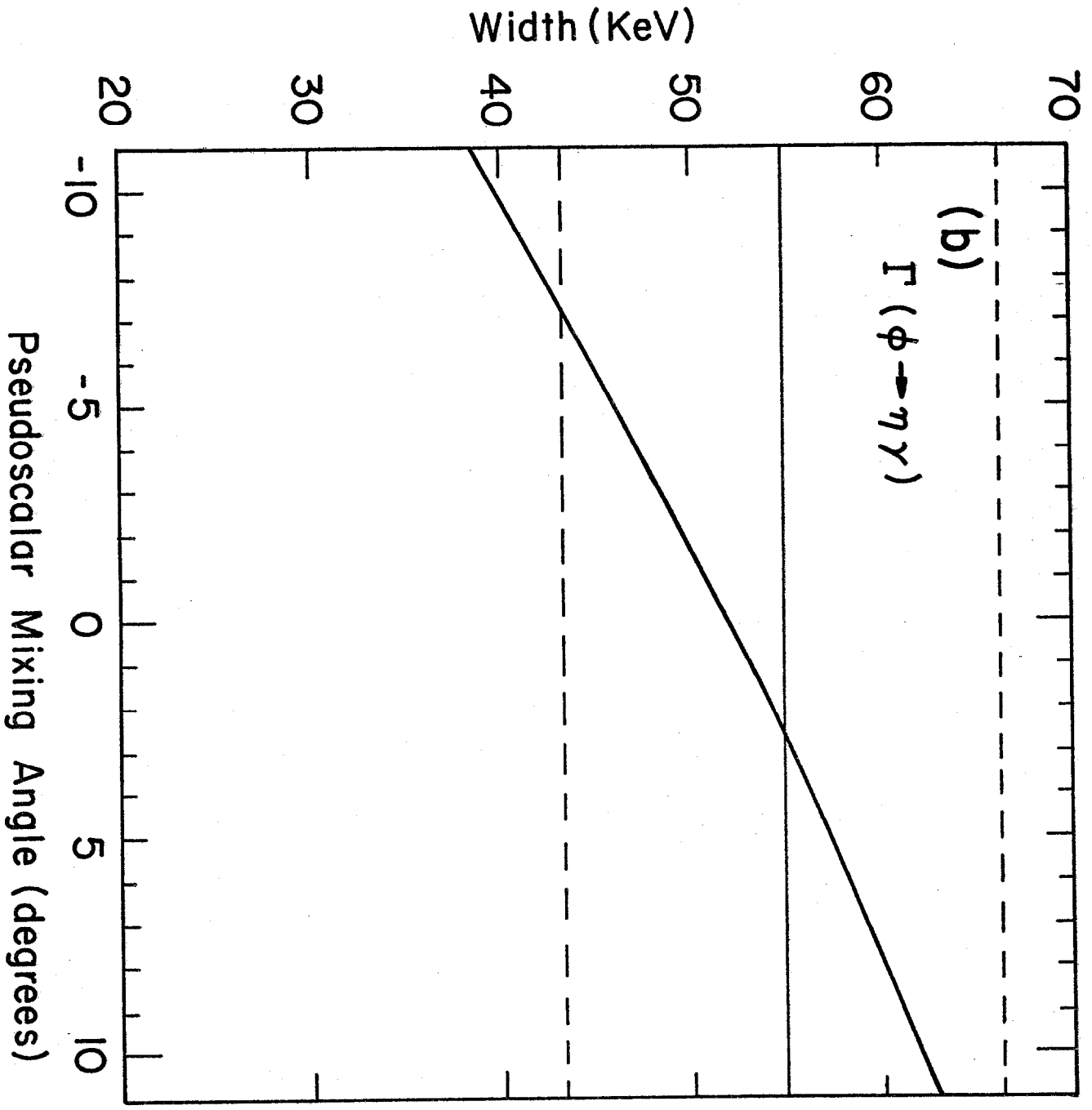
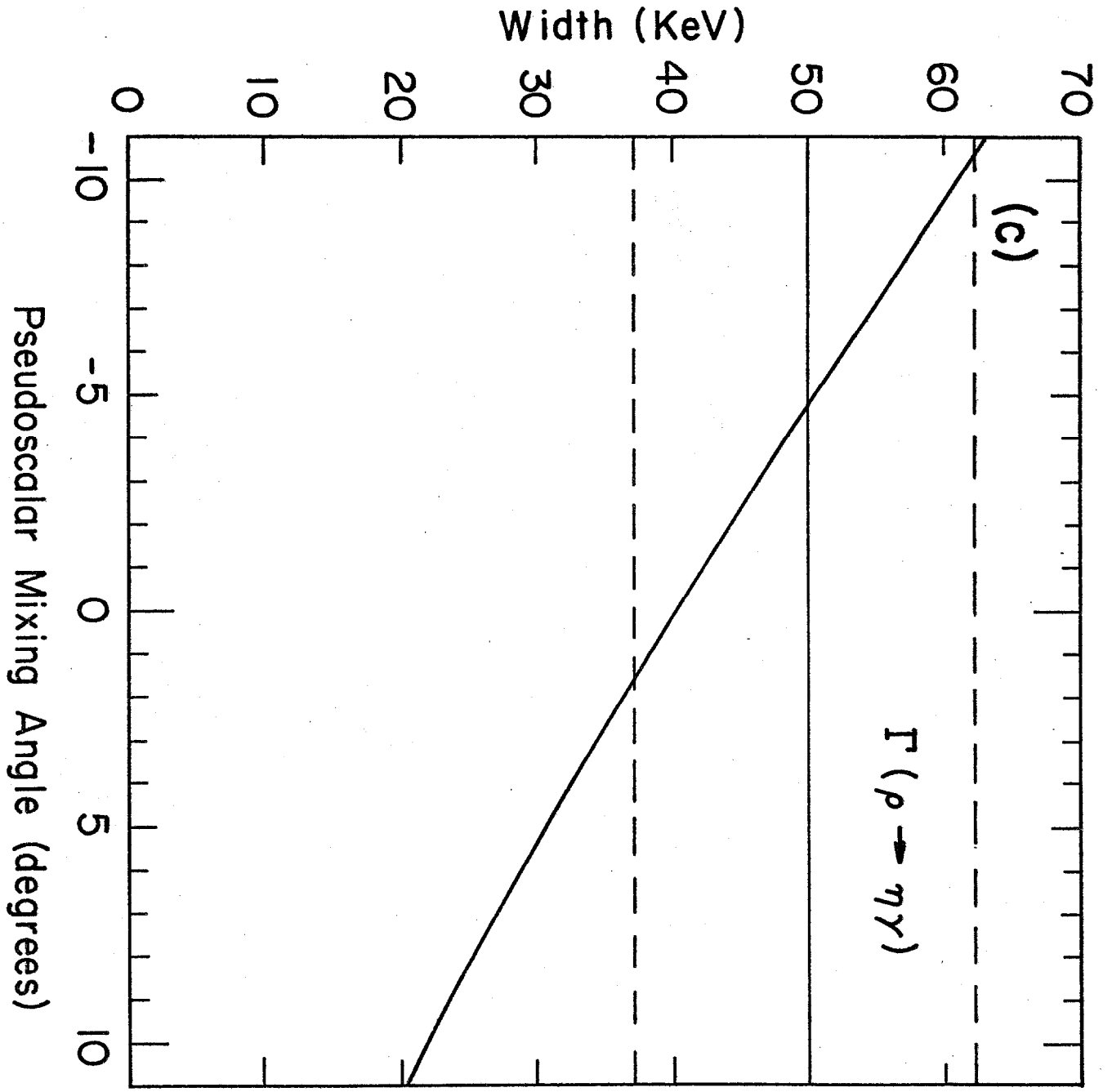

Width (KeV)
20
30
40
50
60
70
-10
-5
0
5
10
Pseudoscalar Mixing Angle (degrees)
(b)
Γ (φ → ηγ)

Fig. 1(b)


Width (KeV)
0
10
20
30
40
50
60
70
-10
-5
0
5
10
Pseudoscalar Mixing Angle (degrees)
(c)
Γ(ρ → ηγ)

(Fig. 1(c)